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Technical Report on Ammunition Can Strap Verification

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U.S. Army Tank Automotive Research,
Development, and Engineering Center
Detroit Arsenal
Warren, Michigan 48397-5000

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1.0 SUMMARY:

Twenty-four (24) Pull tests were performed on 12 utility straps provided to the Vehicle Armor Lab (VAL) by The Program Management Office for the Mine Resistant Armored Vehicle Program (PM-MRAP). These tests were performed to verify the results of contractor testing. The testing found that the contractor was meeting the required specs. However, a couple of different anomalies were identified and noted. It was discovered that the Large Straps did not perform, or fail consistently. Also, it was noted that the buckle retainer on the smaller Straps loosened over time.

2.0 INTRODUCTION:

PM-MRAP requested that The VAL perform some verification tests for some of their utility straps. These utility straps are used for a wide variety of applications, but primarily for strapping down ammo cans. The PM office rep asked us to perform independent verification of their contractor's test. These tests were aimed at ensuring that the contractor, Sturge, was meeting their contractual requirements. This test was an independent verification of tests that were already performed.

Our Lab was equipped to perform the test as described by PM-MRAP. The original set-up for the tests was done vertically as shown in Figure 1.



Figure 1. Sturge's original Test set-up

The tests as performed at TARDEC would be performed horizontally in a similar fashion. This was considered acceptable due to the part being placed in tension, gravity would not be a factor. TARDEC's set-up is shown below in Figure 2.

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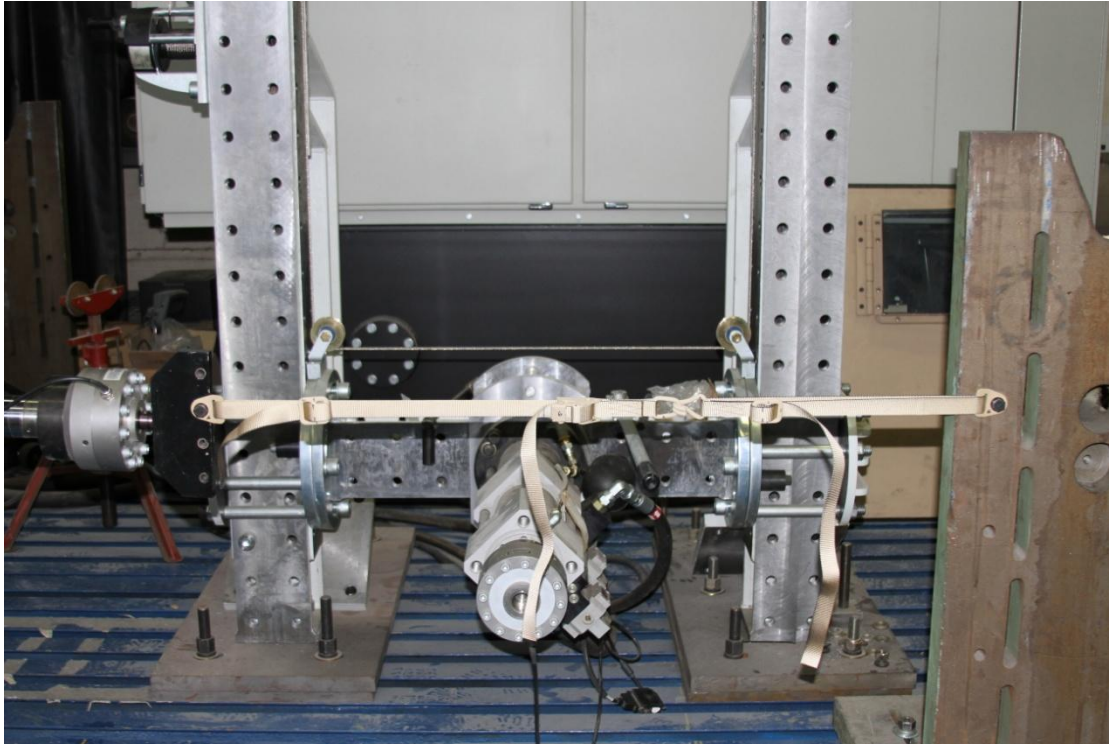


Figure 2. TARDEC Test Set-up

3.0 Test Method:

The test method that was used was gained straight from the contractor's test reports. The strap was harnessed on both ends at the "D" rings and a pull test was performed at a constant rate of 5"/Min.

Equipment:

- 6 1-3/4" Strap assemblies
- 6 1" Strap assemblies
- 12 12mm 10.5 grade bolts 40mm long (with nut and washer)
- 12 12mm 10.5 grade bolts 80mm long (with nut and washer)

Instron 3027 IST machine with 100kN actuator

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4.0 Assumptions:

Several Assumptions and/or test deviations were made and noted.

1. TARDEC tested the specimen horizontally instead of vertically.
2. The VAL machine test span was limited to 6 in. (5.8 in. was used). According to data provided from previous tests 6in. was more than sufficient travel. However, we tested to failure at the request of PM-MRAP which did require more travel. This was handled as stated in the procedure (see below).
3. Sample 1 – Test 1 (1-3/4" strap assy.) did not have markings or video results.
4. Sample1 – Test 1 (1" strap assy.) did not have markings.

5.0 Procedure:

The following procedure was followed for each Sample and Test:

1. Sample was mounted into the test frame. The strap assembly was attached at each D-ring. Each D-ring was bolted to the test fixture. Bolts were tightened to a preload of 72 in-lbs. of torque. This is the standard torque for 10.5 12mm bolts.
2. Each sample was assembled with a strap tension. The strap tension is recorded for each sample.
3. Each sample is marked with a pen for slippage.
4. Each test is video recorded, manual synchronization with test beginning.
5. Test is run; actuator is pulled at 5"/min over the entire span of 5.8".
6. Part is analyzed for failure.
 - a. If sample has failed, then the sample is unloaded and a new sample is begun.
 - b. If it has been determined that the sample has not failed, the sample is retightened (at the buckle) and retested. This occurred when there was no rupture – only slippage.

6.0 Discussion:

There are several pieces of data that were recorded for each Test.

1. Sample and Test number
2. Belt Pretension.
3. Video of actual test
4. Markings on the belt that tell us where the belt started. This is to monitor slippage.
5. Load and Displacement data from the actuator.
6. Pictures of each sample after testing.

Any exceptions to this data are documented in Section 4.0. The video data is not possible to put into the report due to the size and format of the data. However, the data is available.

7.0 Results

Test 1 (Large 1-3/4" Straps):

Sample Number: 1

Belt Preload: 119.4 lbs.

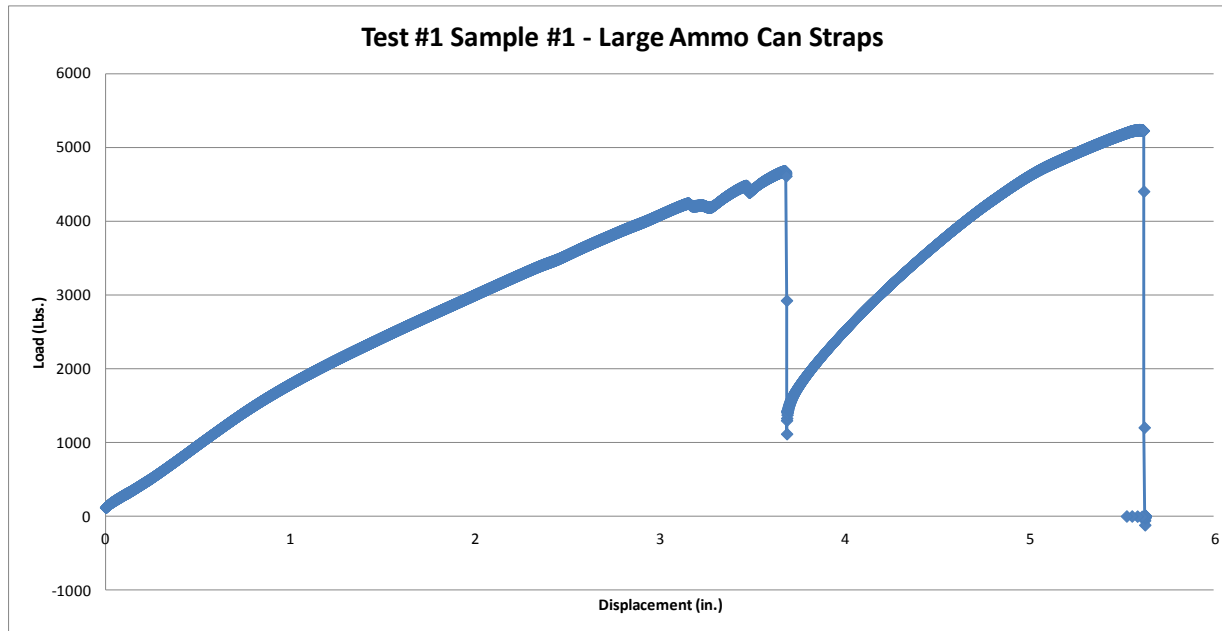


Figure 3. Graph for Test 1(Large Straps).

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Test 2 (Large 1-3/4" Straps):

Sample Number: 1

Belt Preload: 120.7 lbs.

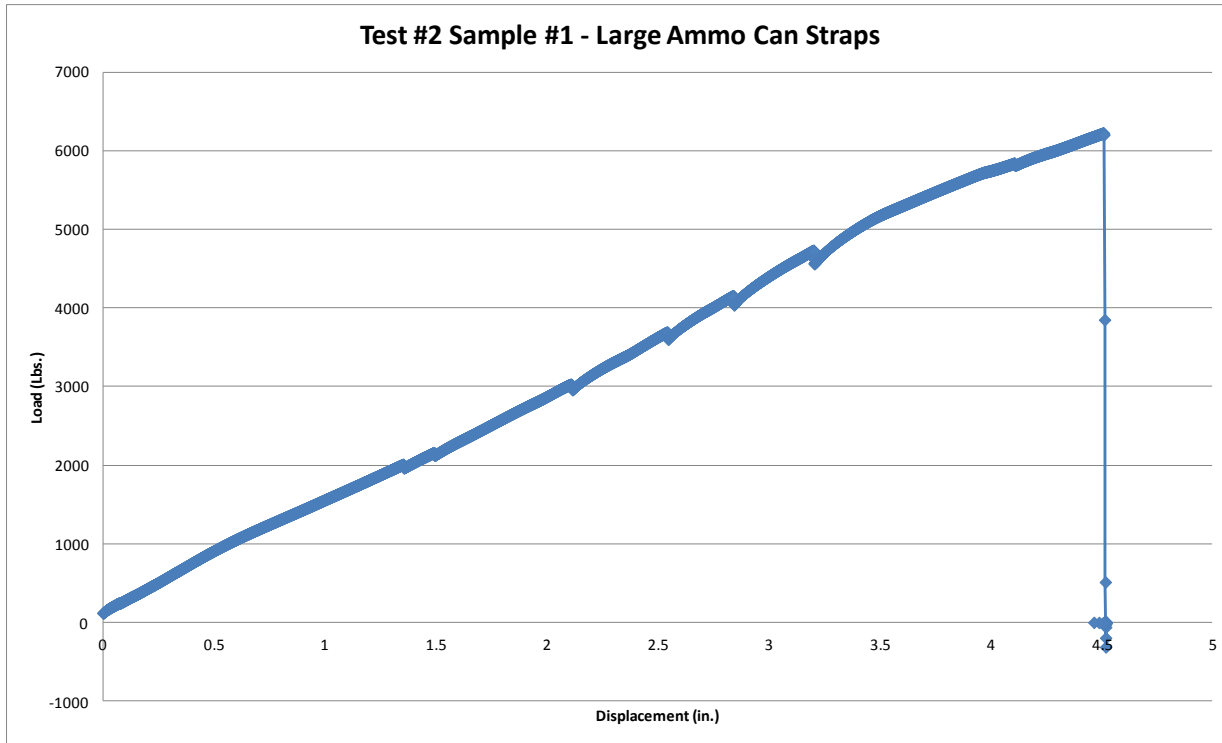


Figure 4. Graph for Test 2(Large Straps).



Figure 5. Sample 1 After Failure.

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Test 3 (Large 1-3/4" Straps):

Sample Number: 2

Belt Preload: 115.25 lbs.

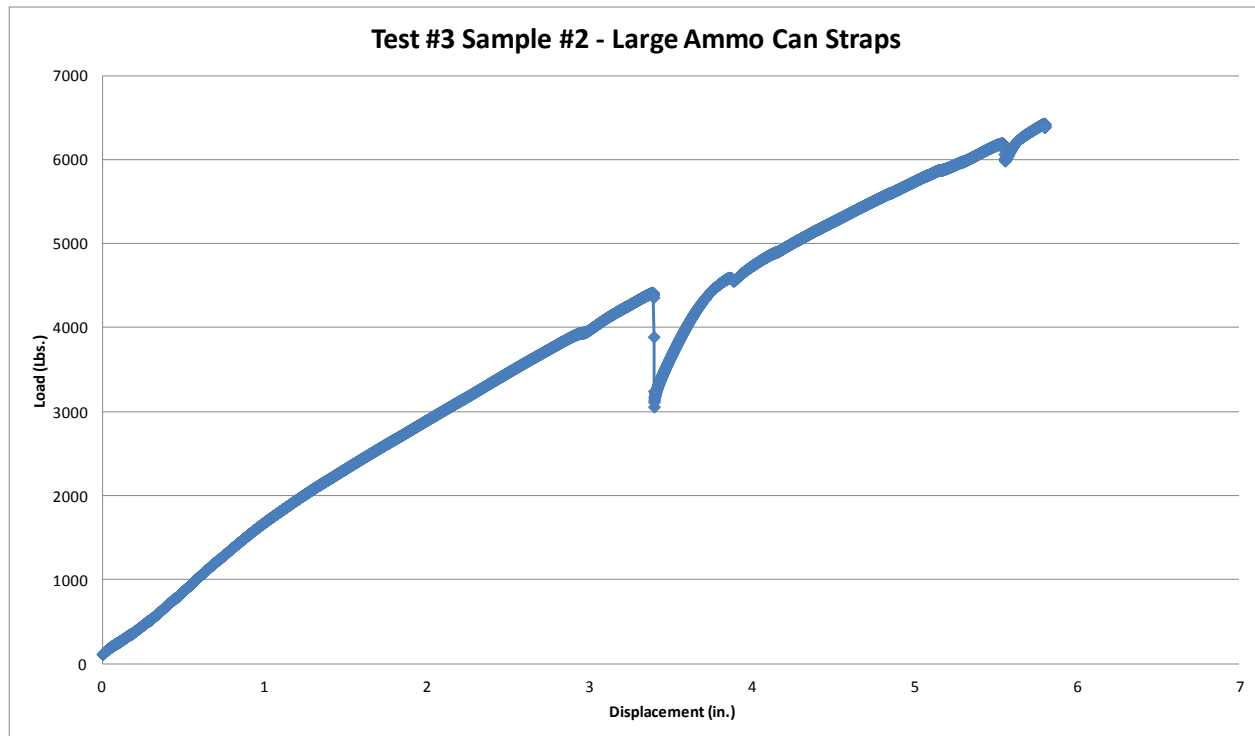


Figure 6. Graph for Test 3(Large Straps).

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Test 4 (Large 1-3/4" Straps):

Sample Number: 2

Belt Preload: 109.8 lbs.

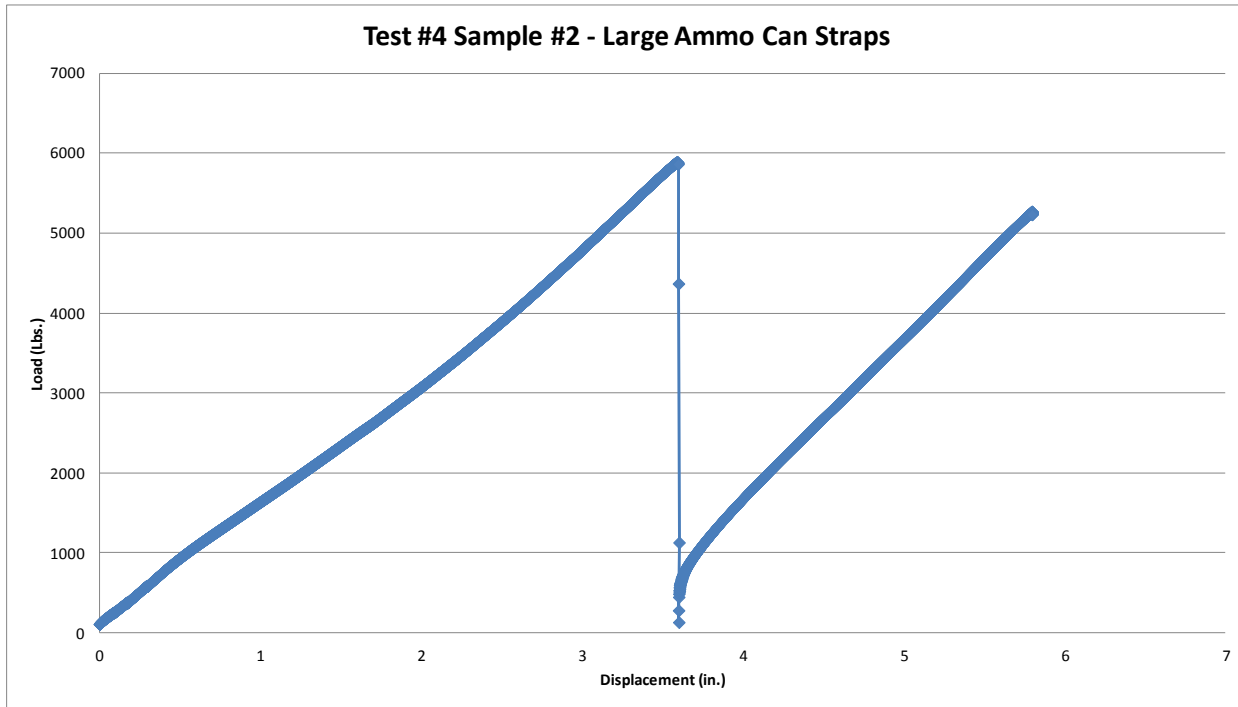


Figure 7. Graph for Test 4(Large Straps).



Figure 8. Sample 2 After Failure.

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Test 5 (Large 1-3/4" Straps):

Sample Number: 3

Belt Preload: 112.5 lbs.

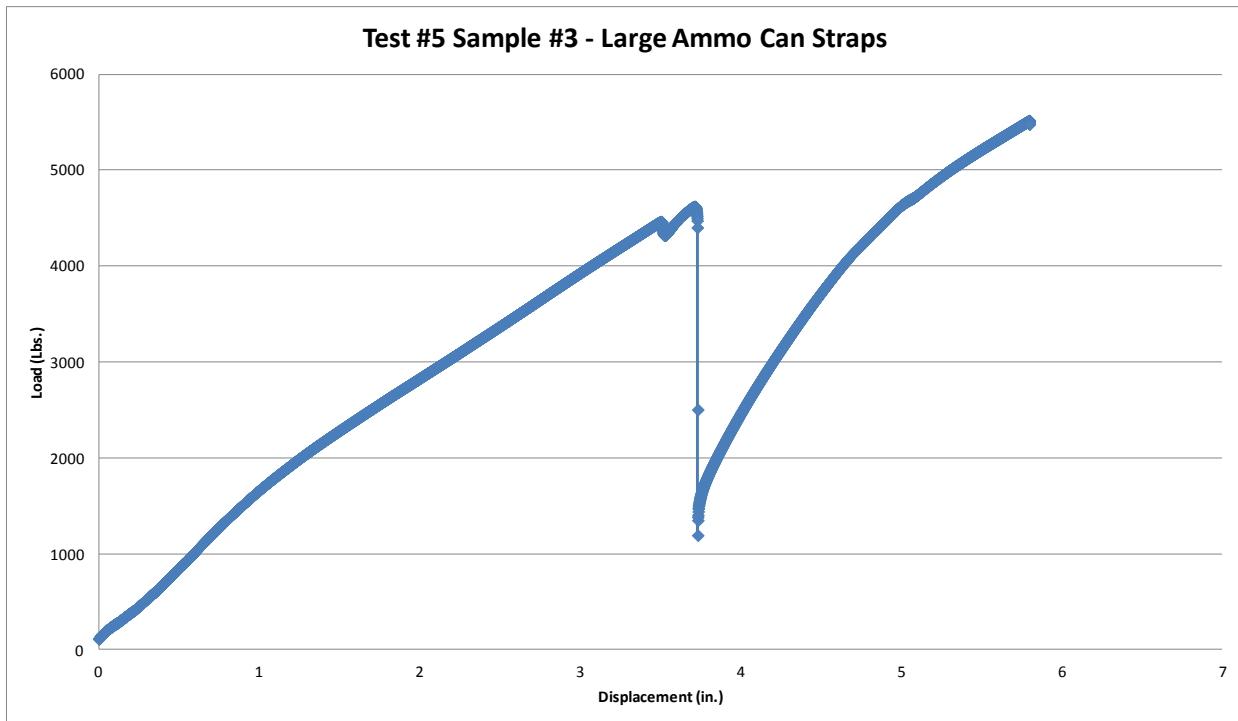


Figure 9. Graph for Test 5(Large Straps).

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Test 6 (Large 1-3/4" Straps):

Sample Number: 3

Belt Preload: 112.5 lbs.

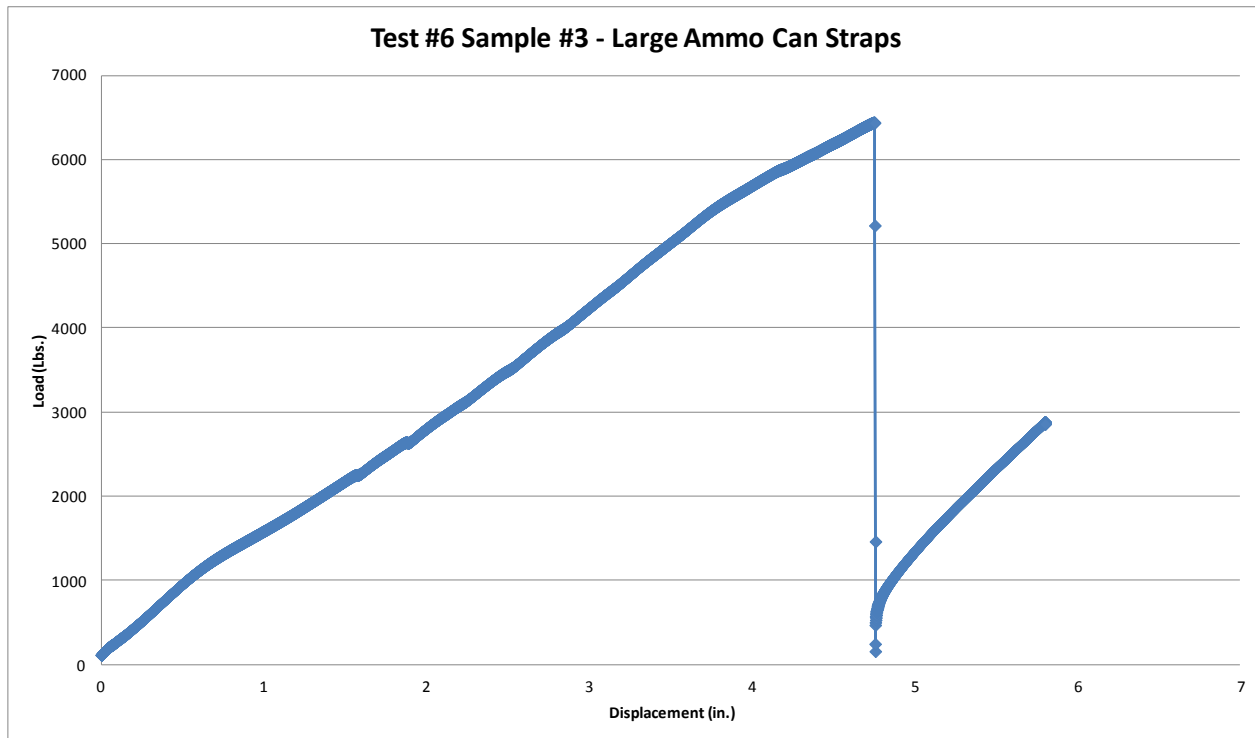


Figure 10. Graph for Test 6(Large Straps).



Figure 11. Sample 3 After Failure.

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Test 7 (Large 1-3/4" Straps):

Sample Number: 4

Belt Preload: 120.7 lbs.

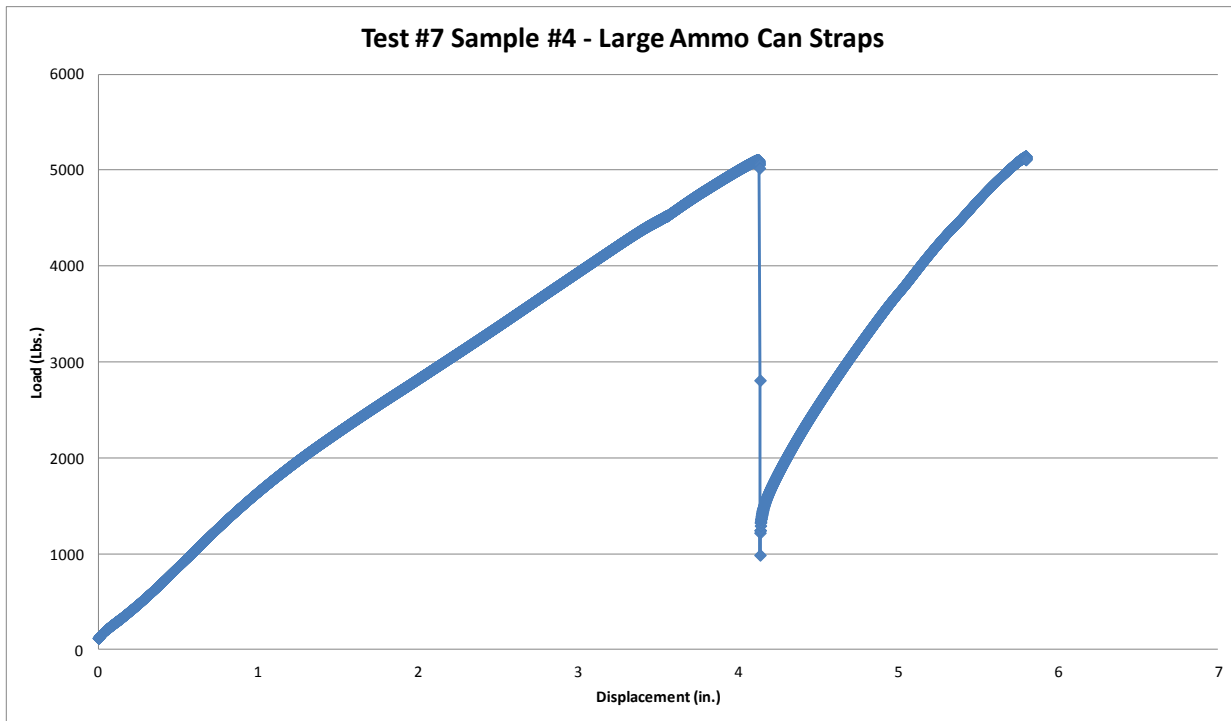


Figure 12. Graph for Test 7(Large Straps).

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Test 8 (Large 1-3/4" Straps):

Sample Number: 4

Belt Preload: 133.1 lbs.

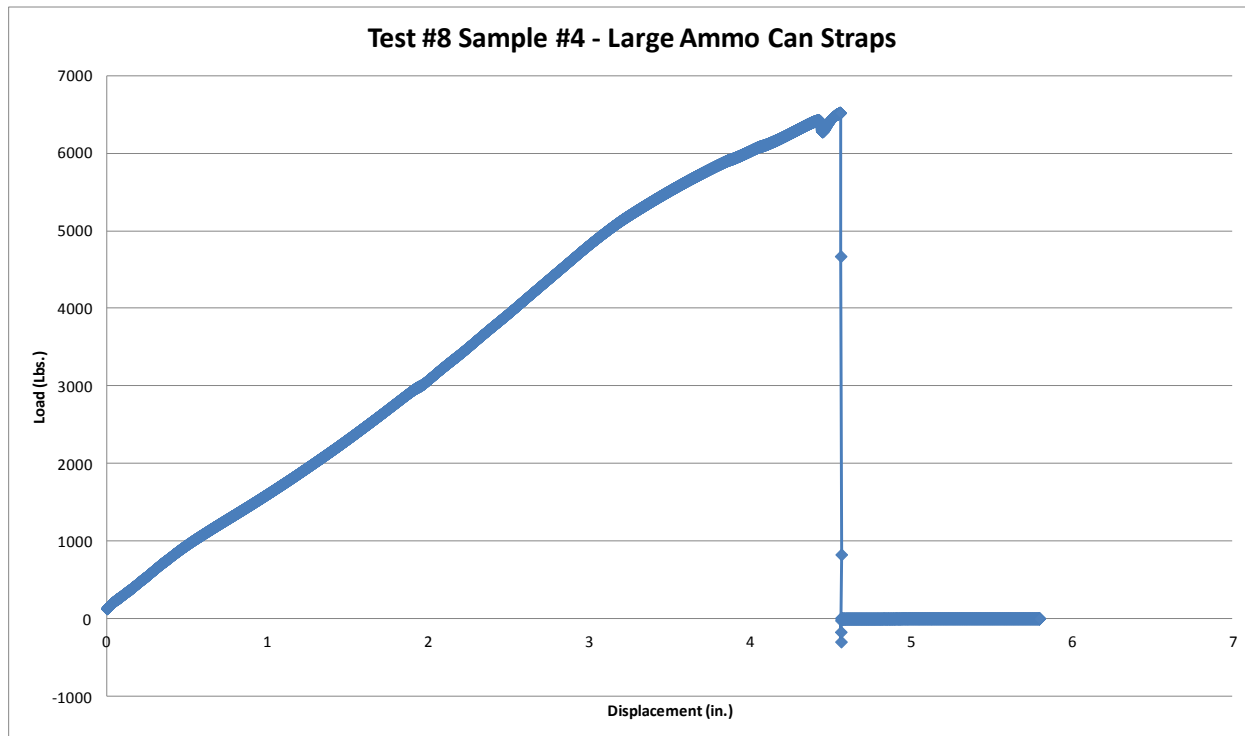


Figure 13. Graph for Test 8(Large Straps).



Figure 14. Sample 4 After Failure – Latching hardware failed.

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Test 9 (Large 1-3/4" Straps):

Sample Number: 5

Belt Preload: 116.6 lbs.

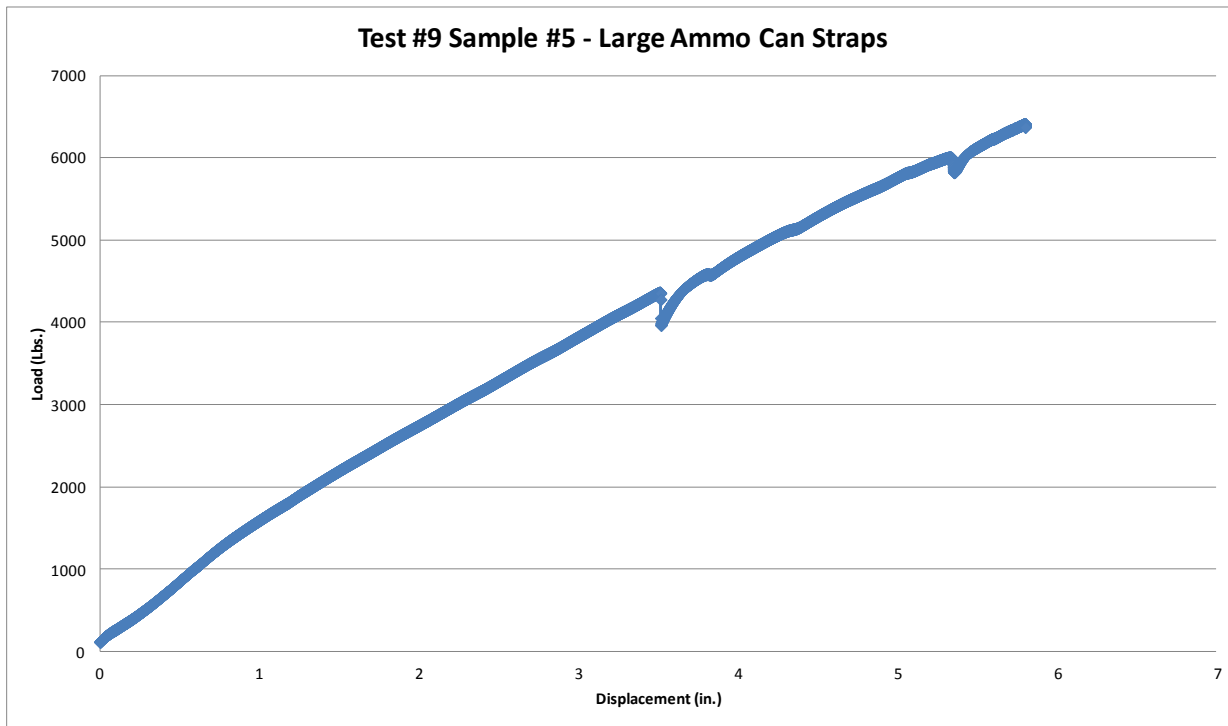


Figure 15. Graph for Test 9(Large Straps).

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Test 10 (Large 1-3/4" Straps):

Sample Number: 5

Belt Preload: 135.8 lbs.

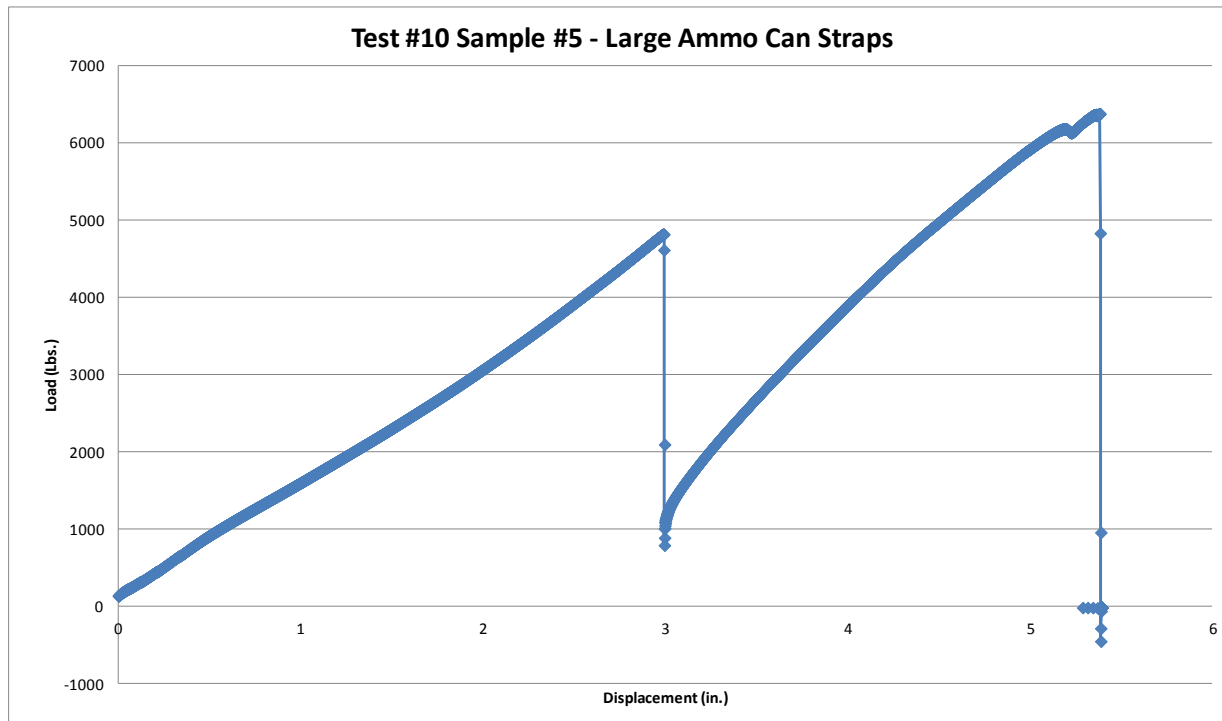


Figure 16. Graph for Test 10(Large Straps).



Figure 17. Sample 5 after failure.

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Test 11 (Large 1-3/4" Straps):

Sample Number: 6

Belt Preload: 123.4 lbs.

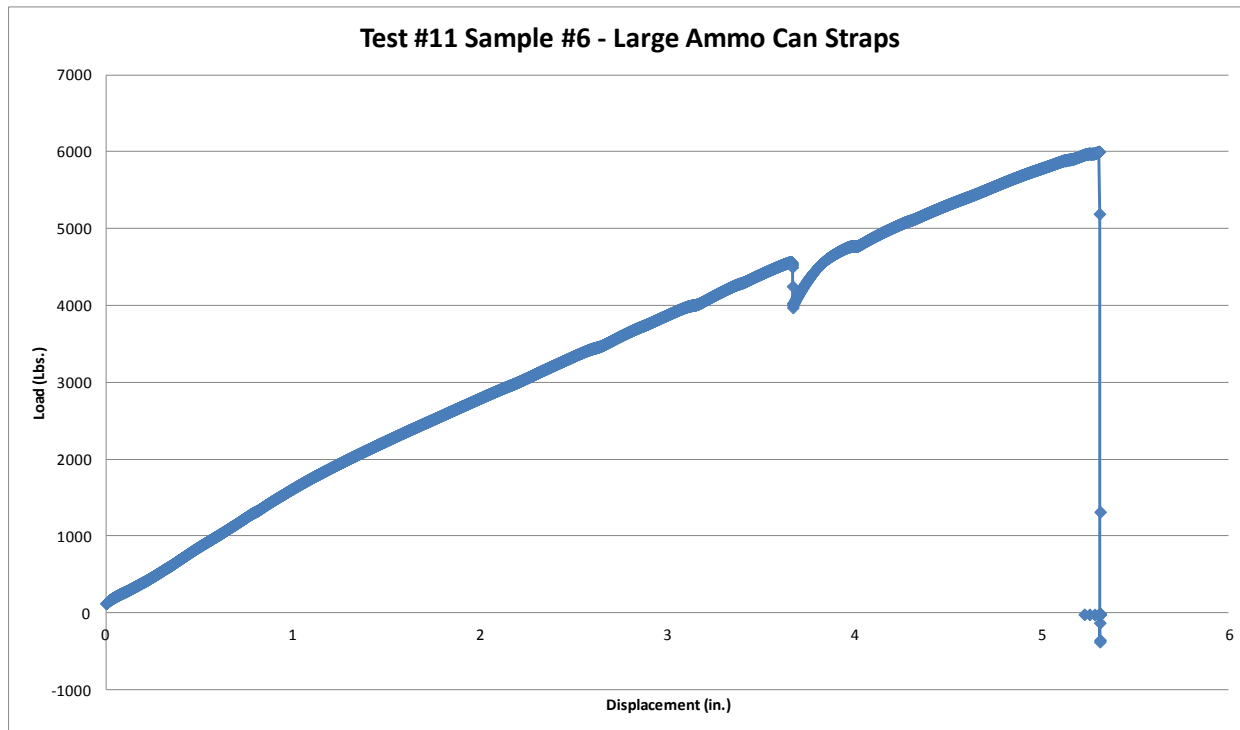


Figure 18. Graph for Test 11(Large Straps).



Figure 19. Sample 6 after failure.

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Test 1 (Small 1" Straps):

Sample Number: 1

Belt Preload: 59 lbs.

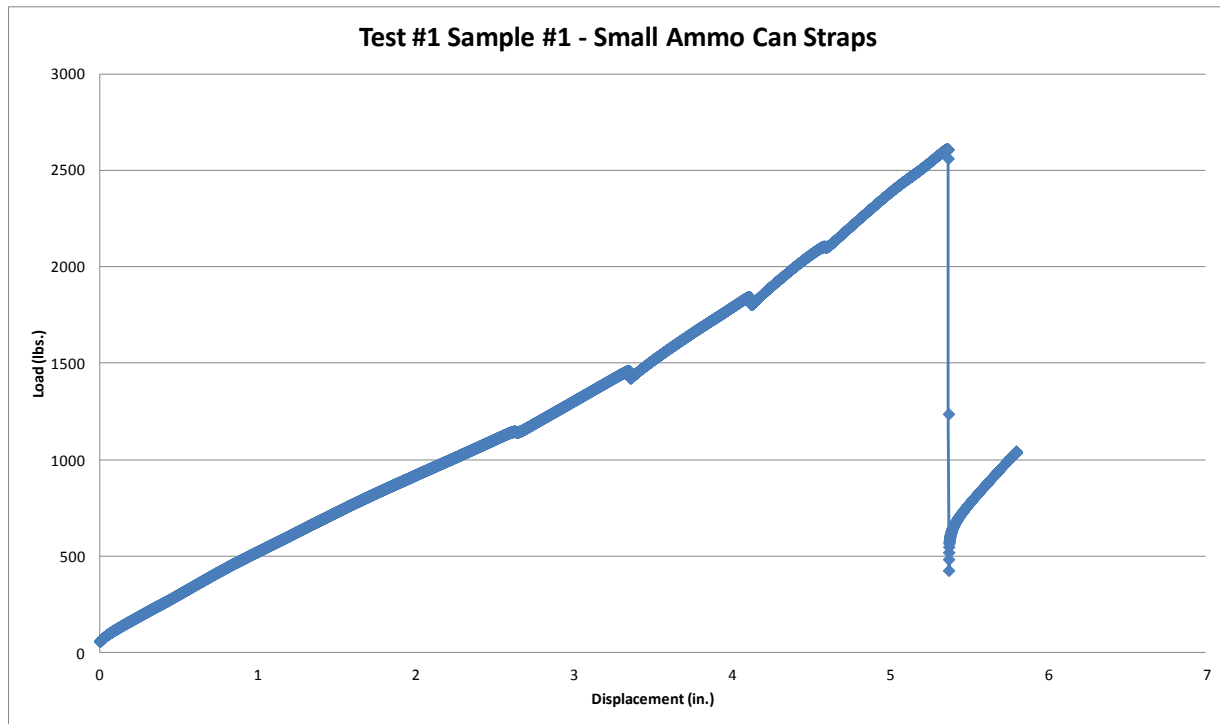


Figure 20. Graph for Test 1 (Small Strap).

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Test 2 (Small 1" Straps):

Sample Number: 1

Belt Preload: 52 lbs.

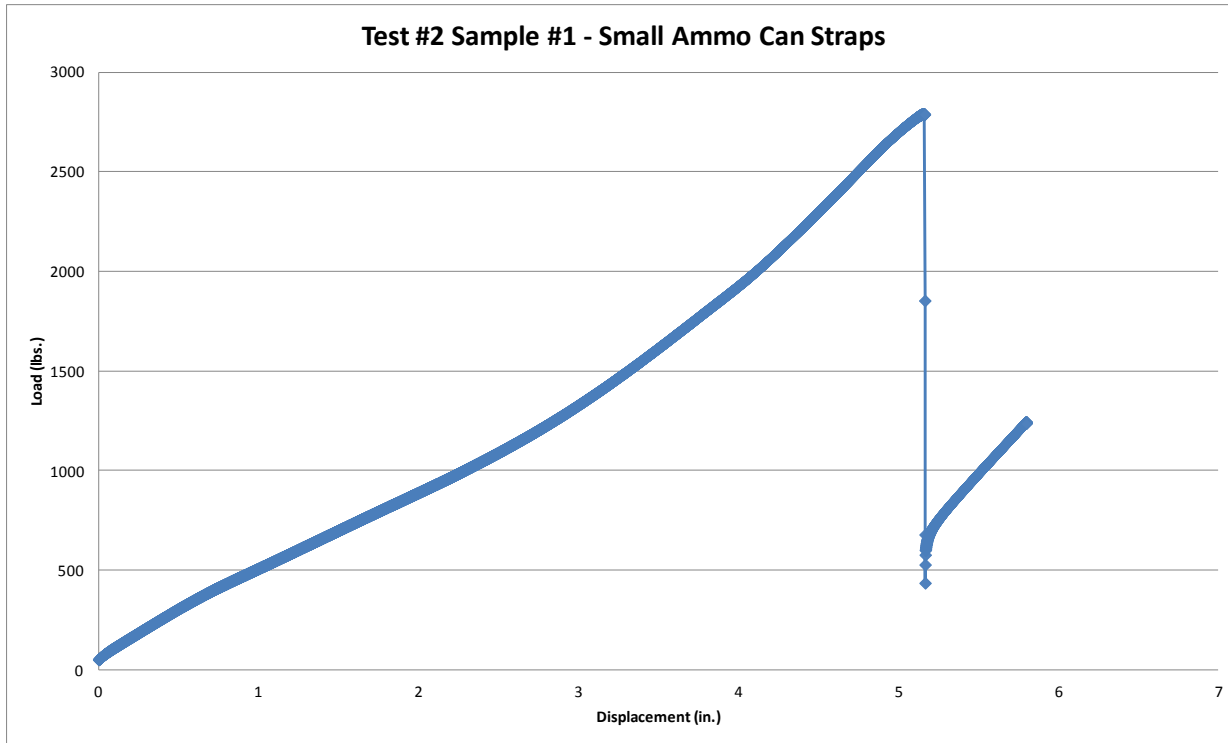


Figure 21. Graph for Test 2 (Small Strap).



Figure 22. Sample 1 After Failure.

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Test 3 (Small 1" Straps):

Sample Number: 2

Belt Preload: 59 lbs.

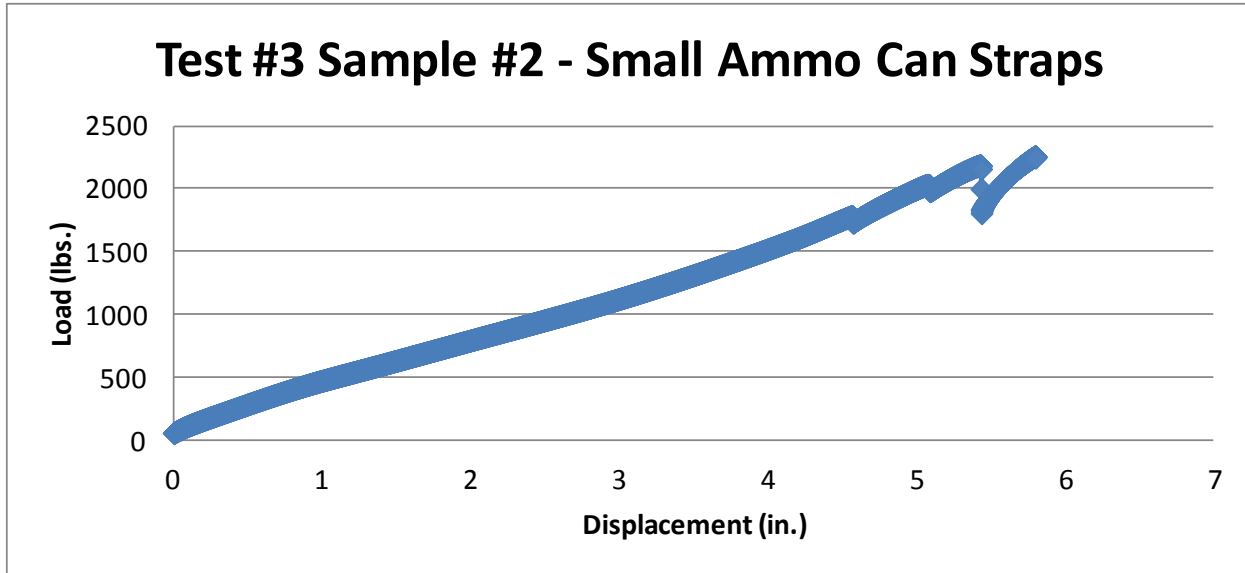


Figure 23. Graph for Test 3 (Small Strap).

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Test 4 (Small 1" Straps):

Sample Number: 2

Belt Preload: 78 lbs.

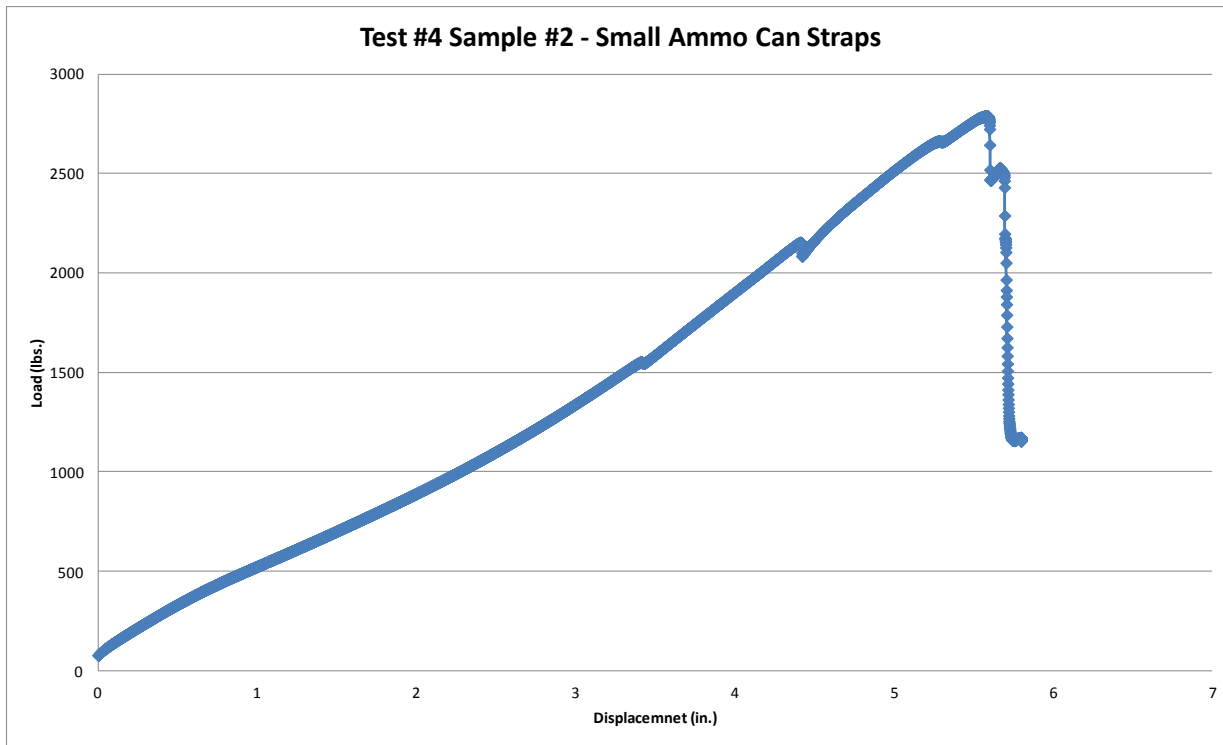


Figure 24. Graph for Test 4 (Small Strap).



Figure 25. Sample 2 After Failure.

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Test 5 (Small 1" Straps):

Sample Number: 3

Belt Preload: 79 lbs.

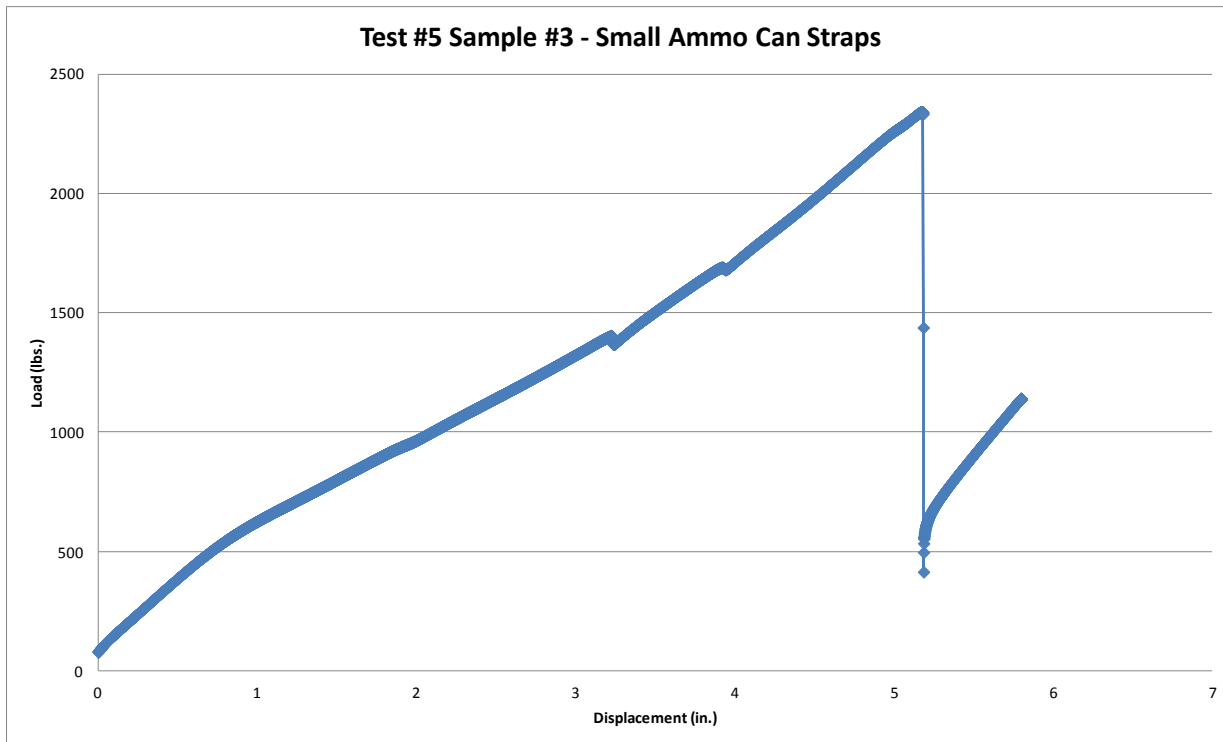


Figure 26. Graph for Test 5 (Small Strap).



Figure 27. Sample 3 After Failure.

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Test 6 (Small 1" Straps):

Sample Number: 4

Belt Preload: 83.7 lbs.

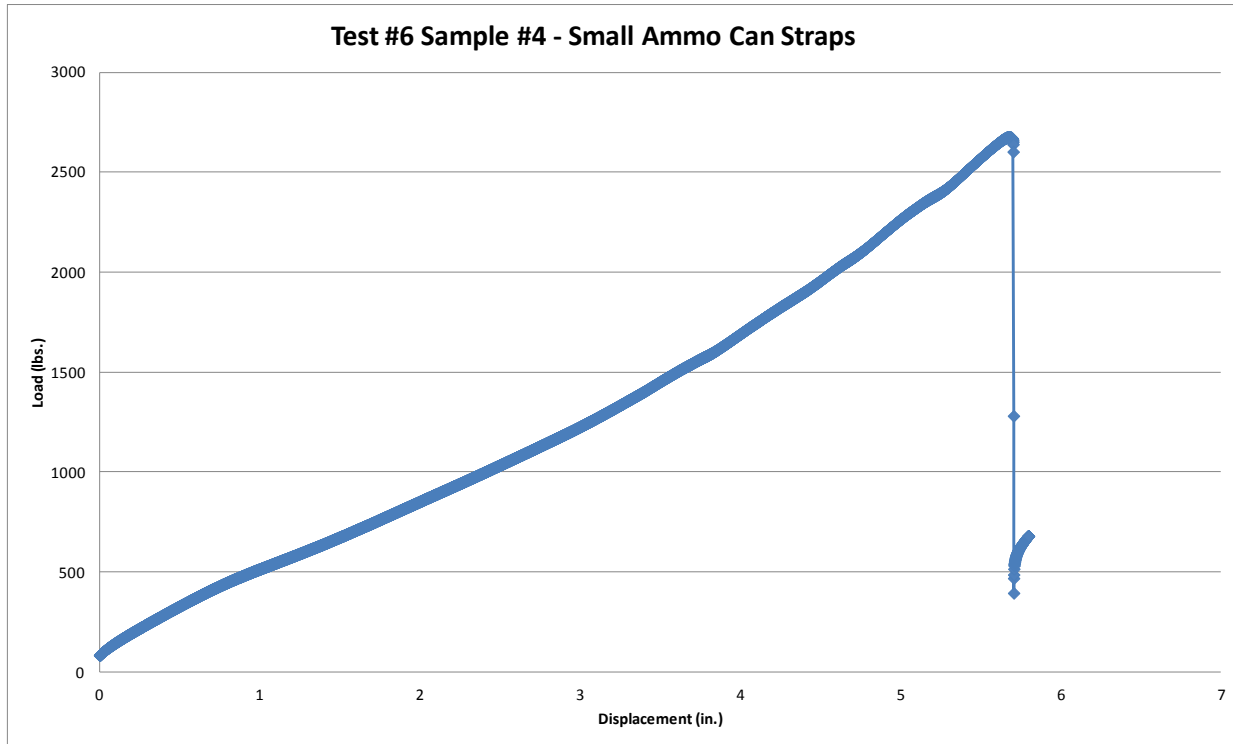


Figure 28. Graph for Test 6 (Small Strap).



Figure 29. Sample 4 After Failure.

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Test 7 (Small 1" Straps):

Sample Number: 5

Belt Preload: 85.7 lbs.

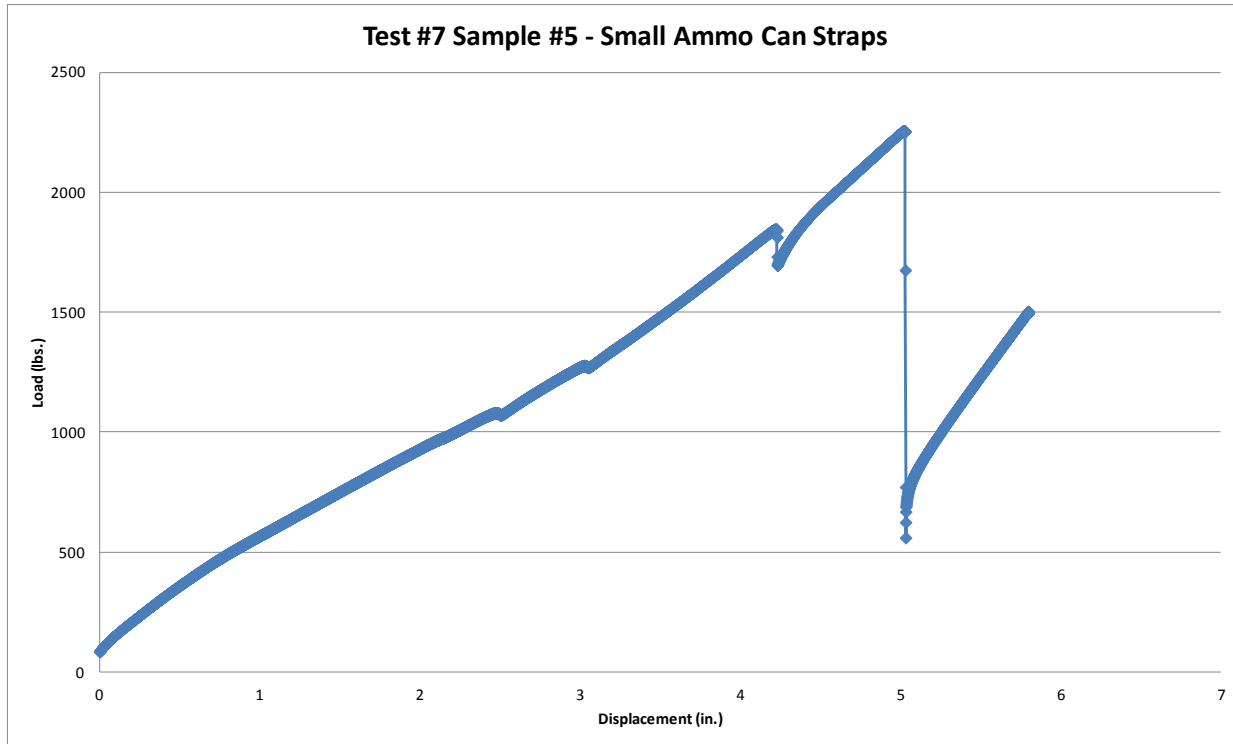


Figure 30. Graph for Test 7 (Small Strap).



Figure 31. Sample 5 After Failure.

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Test 8 (Small 1" Straps):

Sample Number: 6

Belt Preload: 81 lbs.

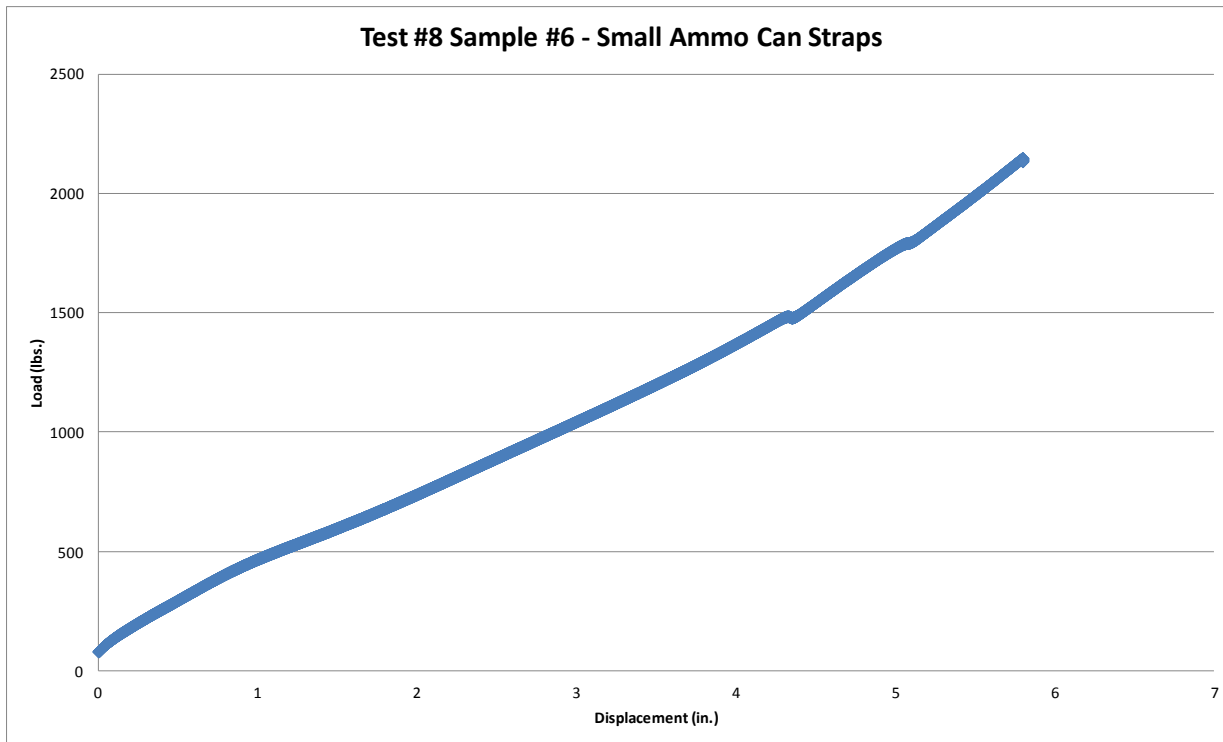


Figure 32. Graph for Test 8 (Small Strap).



Figure 33. Sample 6 After Failure.

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8.0 Conclusions:

All of the tests passed the failure criteria that was established by the PM office. The large (1-3/4" straps) needed to be rated to fail in excess of 5000lbs., and the small straps were rated to fail in excess of 2000 lbs. As shown in the results section, every single test passed. However, it is important to note a few irregularities that were still causes for concern.

1. The large straps had multiple failure points. This is a concern from a safety and from a quality standpoint. From a safety point it is better to drive the failure to consistently occur at a single point of the design. The resultant failures occurring at multiple points could be caused by a design issue or manufacturing quality issue. The resultant parts may not be manufactured with sufficient quality.
2. The smaller straps had a poor design of a latch. The latch was extremely hard to operate. The latch did not want to catch properly at higher tension. Typically it caught uneven which could results in lower performance. In addition, the latch did not hold the tension. We performed a test of the tension levels over time for the 3rd sample and noticed a 50% tension load drop over a 4 hour period. This could be a concern if someone tightens something down and it comes loose enough for it to no longer hold the item.
3. Both large and small straps had a significant amount of slippage. We were unable to accurately assess all the straps and the amount of slippage that occurred. However, we did notice on several samples that we had in excess of 3 in. of slip. The effect of slippage and whether it is good or bad can not be determined within the scope of this effort. There is a possibility that slippage expends energy resulting in the straps working longer without a catastrophic failure. Conversely, the slippage may loosen the grip enough that items will be expelled. We are not in a position within the scope of this effort to argue one way or the other, but the slippage was significant enough on a large number of samples as to be noted for future considerations.

9.0 Recommendations:

Since all of the parts passed the criteria that they were specified to pass, we can conclude that the Contractor is in compliance with the specifications that we were given for him to be in compliance with. However, we are concerned that some of the conclusions may lead to problems down the line that may want to be considered for future improvements.

1. We recommend that the large straps be investigated as to whether there is a design or quality issue and to resolve the issue, which ever it is concluded to be.
2. We recommend that the latch mechanism on the smaller strap be either replaced or redesigned. The mechanism on the larger strap system seems to work adequately. Perhaps, a scaled version of the latch mechanism for the large strap is available.
3. Further studies should be done on the slippage issue. The extent of the slippage, and the extent of the affects of the slippage should be studied.